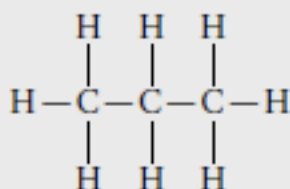


Student Textbook page 549

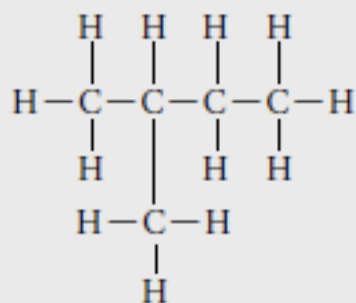
1. (a) 2-methylbutane
(b) 2,2-dimethylpropane
(c) 3-ethyl-2,5-dimethylheptane
(d) 2,2,4,4-tetramethylhexane
(e) 2,2,4-trimethyl-4-propylheptane
2. (a) 2,2,3-trimethylbutane
(b) 5-ethyl-3-methylnonane
(c) 4,5-diethyl-3-methylnonane
3. (a) heptane
(b) 2,3-dimethylpentane
(c) 4-ethyl-2,3-dimethylhexane

Student Textbook page 550–551

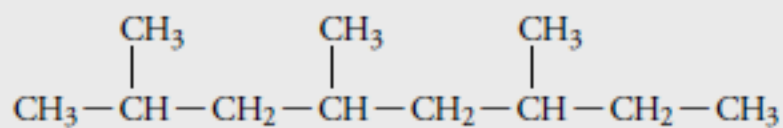
4. (a)



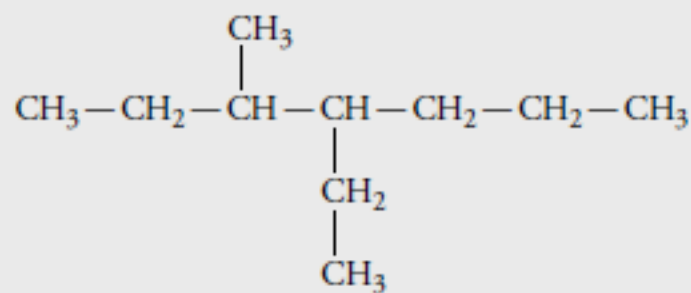
- (b)



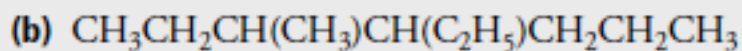
5. (a)



(b)

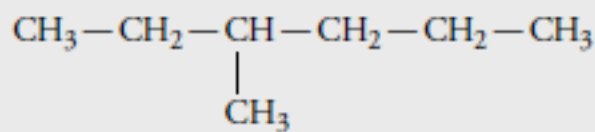


6.

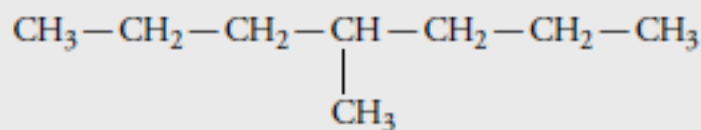


7.

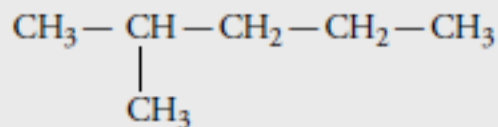
(a)



(b)

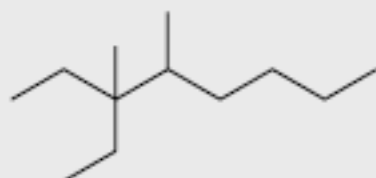


(c)



8.

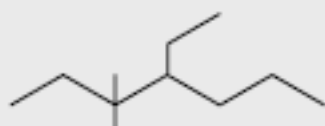
(a)



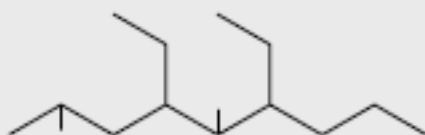
(b)



(c)



(d)



9. (a) The longest continuous chain has 6 carbons, not 5, with two methyl groups (CH_3^-) on carbons C_2 and C_4 . The correct name is 2,4-dimethylhexane.
- (b) The longest continuous chain of 6 carbons should be numbered from right to left. The correct name is 2,3-dimethylhexane.
- (c) The longest continuous chain has 6 carbons, not 5, with an ethyl group (C_2H_5^-) and a methyl group (CH_3^-) on carbon C_3 . The correct name is 3-ethyl-3-methylhexane.

Student Textbook page 554

10. (a) hex-3-ene

(b) hept-2-ene

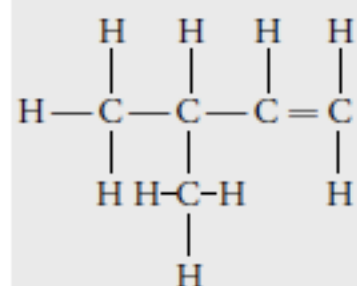
11. oct-4-ene

12. 4,4-dimethylpent-2-ene

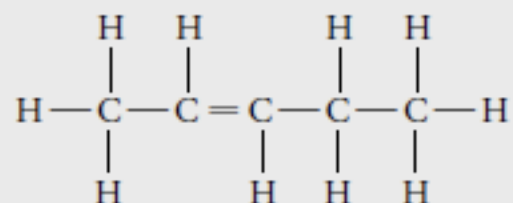
13. 3-ethyl-5-methyl-3-propylhex-1-ene

Student Textbook page 555

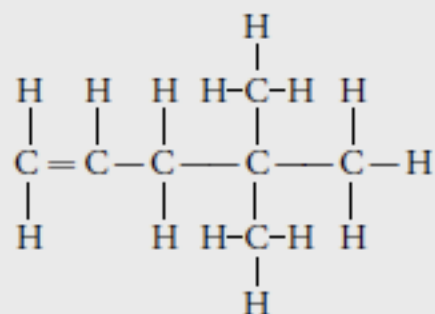
14. (a)



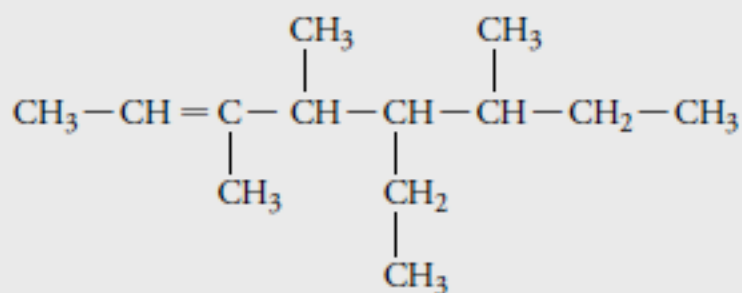
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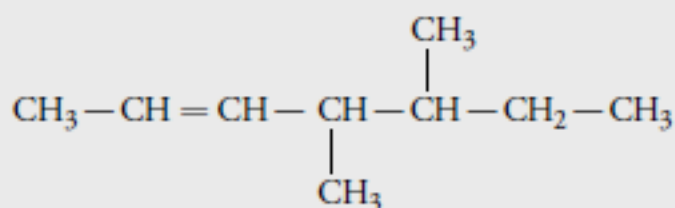
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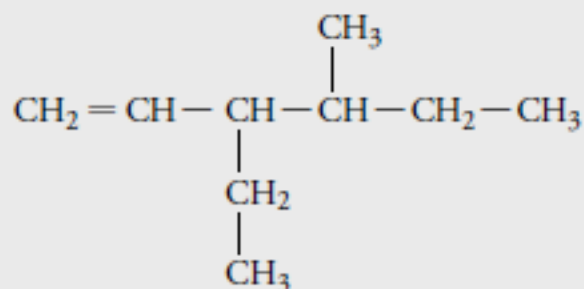
15. (a)



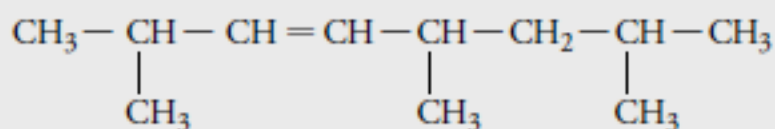
(b)



(c)



(d)

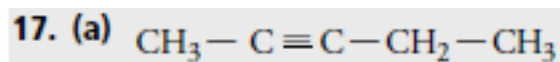


Student Textbook pages 556–557

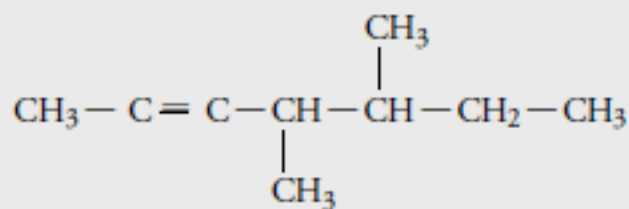
For full solutions to the practice problems, visit
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16. (a) 4,4-dimethylpent-2-yne

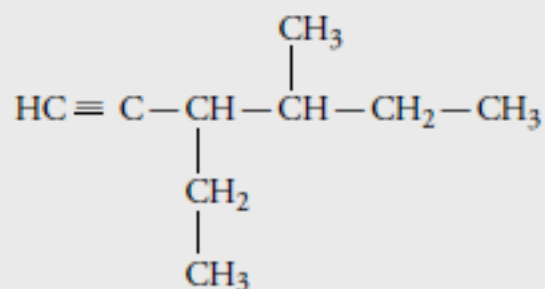
(b) 3-ethyl-5-methyl-3-propylhex-1-yne



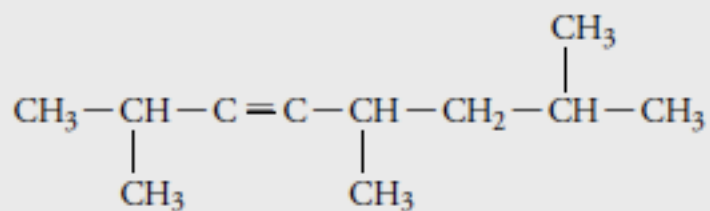
(b)



(c)



(d)



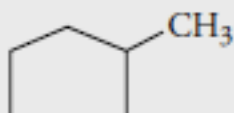
Student Textbook pages 559–560

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 Instructor Edition, Full Solutions.

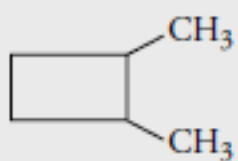
18. (a) methylcyclobutane

(b) 1-ethyl-3-methylcyclopentane

19. (a)



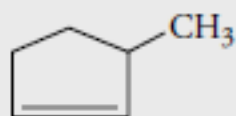
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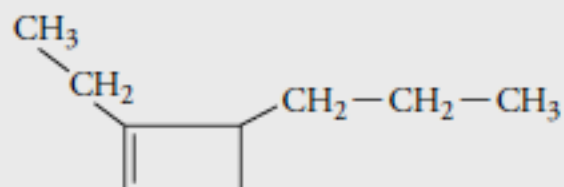
20. (a) 4-methylcyclooctene

(b) 3-methyl-5-propylcyclopentene

21. (a)



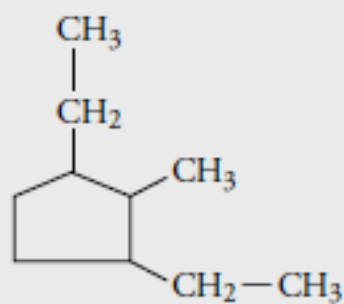
(b)



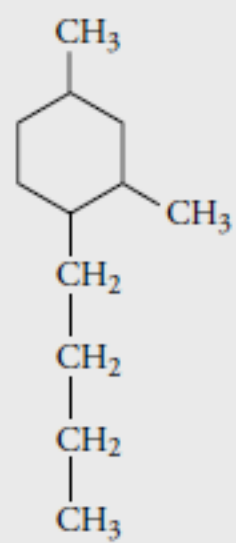
22. (a) 5-ethyl-3,4-dimethylcyclohexene

(b) 3,5-diethylcyclohexene

23. (a)



(b)

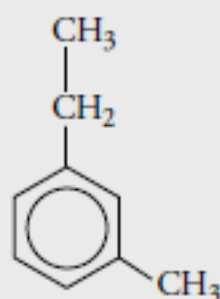


Student Textbook page 562

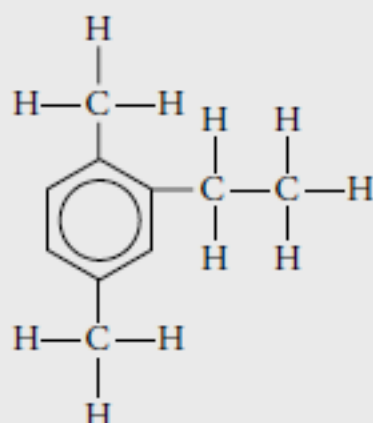
For full solutions to the practice problems, visit www.albertachemistry.ca, Online Learning Centre, Instructor Edition, Full Solutions.

24. 1,3,5-trimethylbenzene

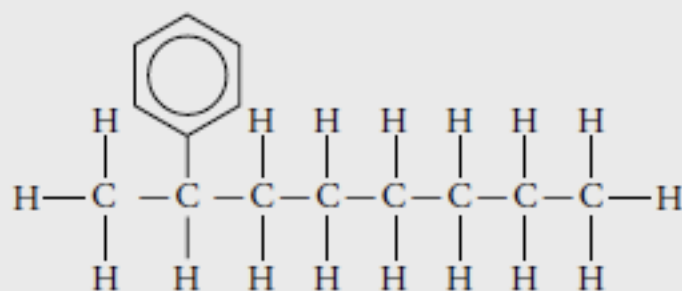
25. (a)



(b)



26.



27. 2,3-diphenylnonane

Student Textbook page 567

For full solutions to the practice problems, visit www.albertachemistry.ca, Online Learning Centre, Instructor Edition, Full Solutions.

28. (a) propan-1-ol

(b) butan-2-ol

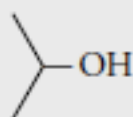
(c) cyclobutanol

(d) pentane-2,3-diol

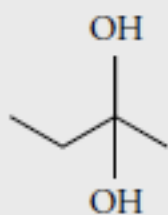
(e) 2,4-dimethylheptan-1-ol

29. (a) $\text{CH}_3 - \text{OH}$

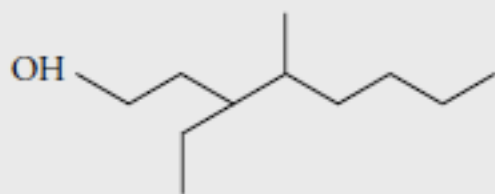
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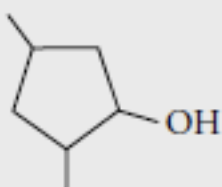
(c)



(d)



(e)



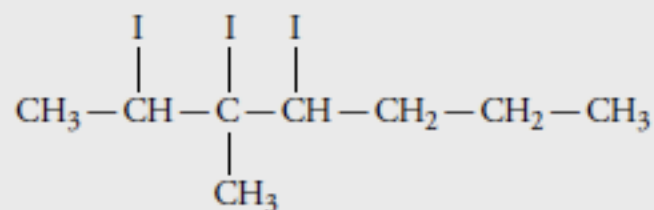
30. (a) pentane-1,3-diol
(b) 3,4-diethyldecane-1-ol
(c) 3-methylpentan-2-ol

Student Textbook page 569

For full solutions to the practice problems, visit www.albertachemistry.ca, Online Learning Centre, Instructor Edition, Full Solutions.

31. (a) 2-bromopropane
(b) 2,3-dichloro-4-fluorohexane
(c) 2,2-dibromo-4-methylpentane

32. (a) $\text{CH}_3 - \text{CH}_2 - \text{Br}$
(b)

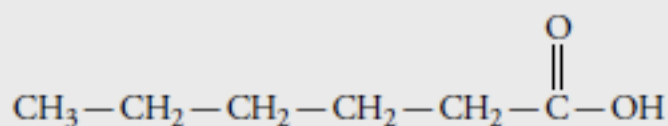


Student Textbook page 570

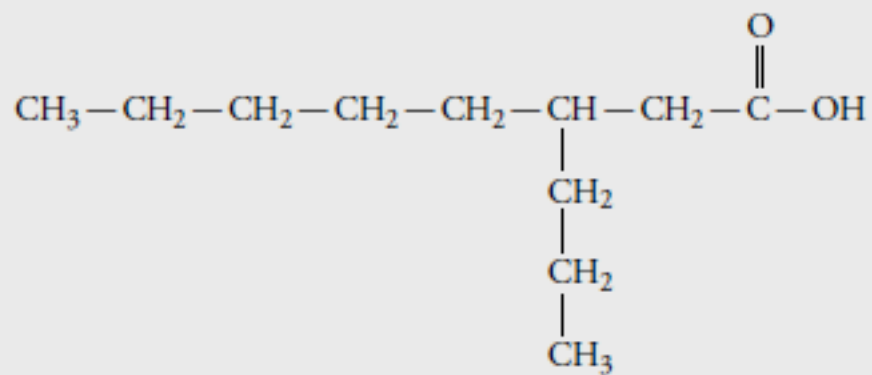
For full solutions to the practice problems, visit www.albertachemistry.ca, Online Learning Centre, Instructor Edition, Full Solutions.

33. (a) propanoic acid
(b) 2,2-dimethylbutanoic acid
(c) 2-ethyl-4,5-dimethylhexanoic acid

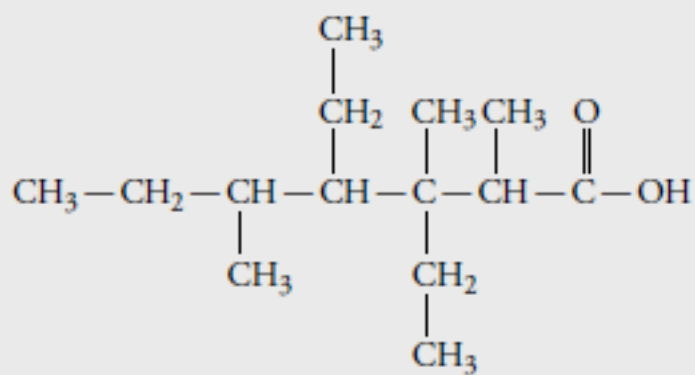
34. (a)



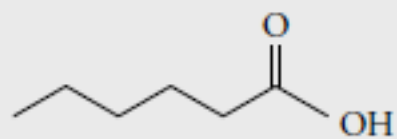
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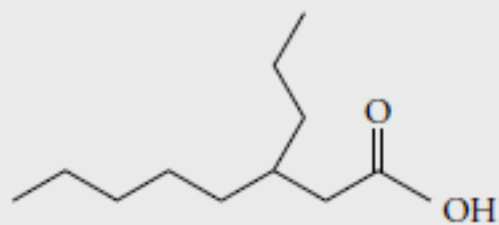
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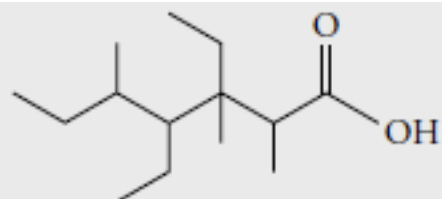
35. (a)



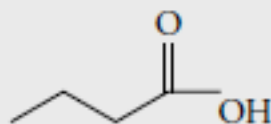
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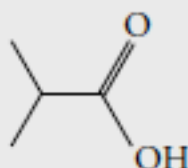
(c)



36. butanoic acid



2-methylpropanoic acid



Student Textbook page 572

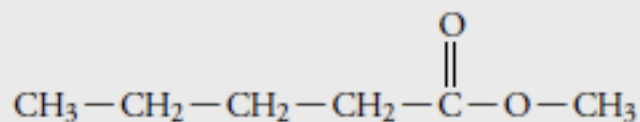
For full solutions to the practice problems, visit
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37. (a) ethyl methanoate

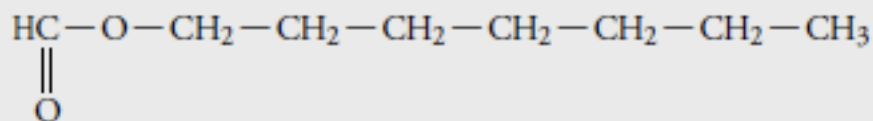
(b) methyl butanoate

(c) pentyl pentanoate

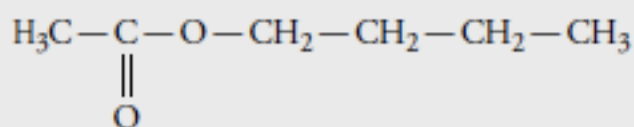
38. (a)



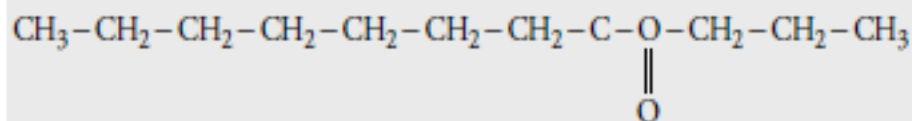
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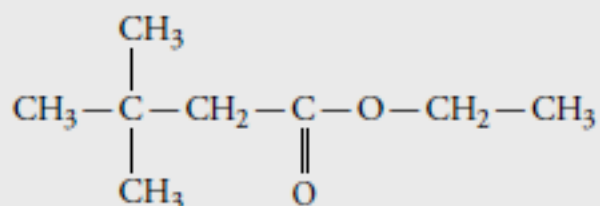
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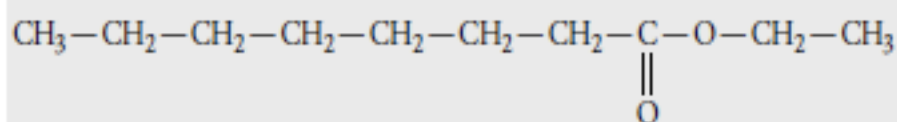
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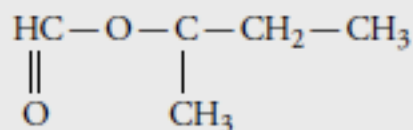
(e)



(f)



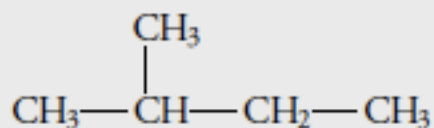
(g)



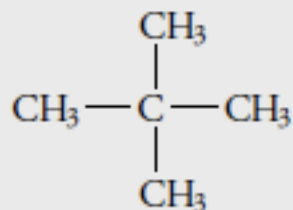
Student Textbook page 573

Q1. pentane $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3$

2-methylbutane



2,2-dimethylpropane



Q2. 1: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$

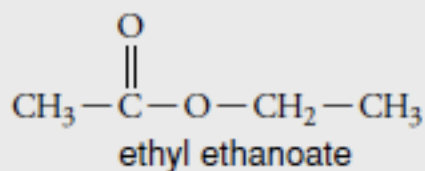
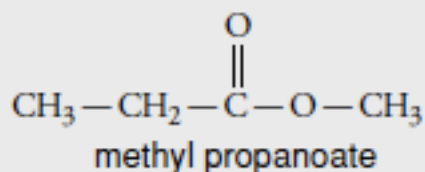
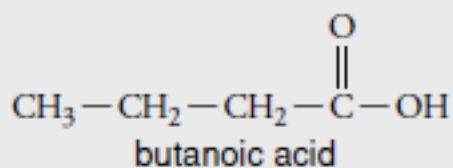
2: $\text{CH}_3\text{CH}_2\text{CH}_2\text{COCH}_3$

Structure 1, a carboxylic acid, would probably have the higher boiling point because it can form hydrogen bonds with itself, which the ester (structure 2) cannot do.

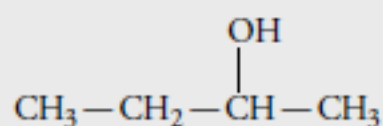
Student Textbook page 574

1. A functional group is a reactive centre for an organic molecule, and is either a polar covalent bond or a multiple bond.
2. The closer the functional group is to the end of a carbon chain the more available it will be to participate in a chemical reaction.
3. An isomer may be defined as a compound that has the same empirical chemical formula as another compound, but with a different arrangement of atoms within the molecule.

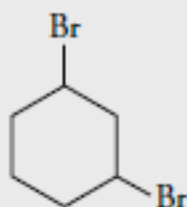
4. The three isomers of $\text{C}_4\text{H}_8\text{O}_2$ are:



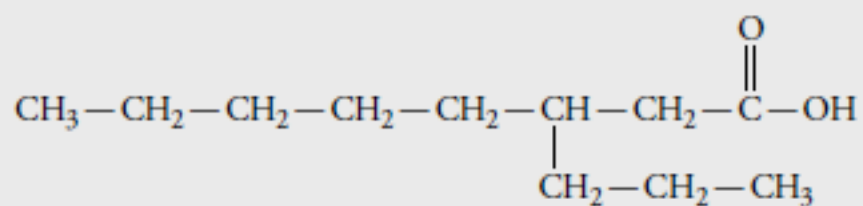
5. London dispersion forces are the most important intermolecular forces between non-polar molecules. For polar molecules, the most important forces are dipole-dipole bonding and possibly hydrogen bonding.
6. (a) 3-chloro-4-fluoro-2,2,3,4,5,5-hexamethylhexane
(b) methyl butanoate
(c) 2,4-dimethylheptan-1-ol
(d) 2-ethyl-4,5-dimethylhexanoic acid
(e) 4-ethyl-2,3-dimethylhexane
(f) 1-ethyl-2-methylcyclopentane
(g) 5,6-dimethylheptan-3-ol
(h) 2,5-dimethylhex-3-ene
(i) 1-bromo-3-chlorocyclobutane
(j) 1,3,5-trimethylbenzene
(k) 3-methylhex-3-ene
(l) pentanoic acid
(m) methyl butanoate
7. (a)



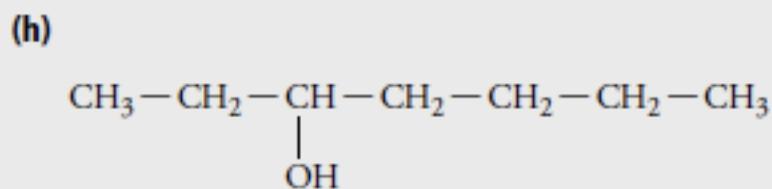
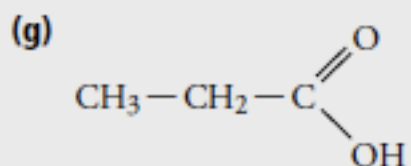
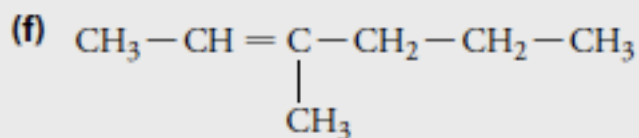
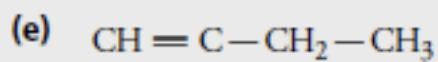
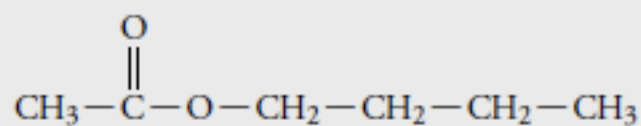
(b)



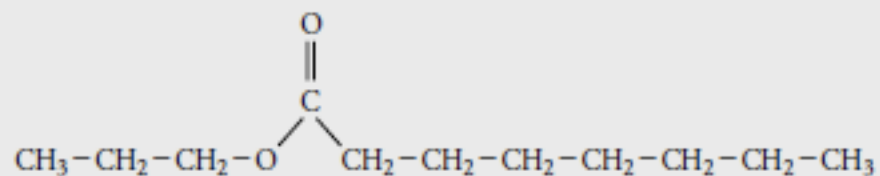
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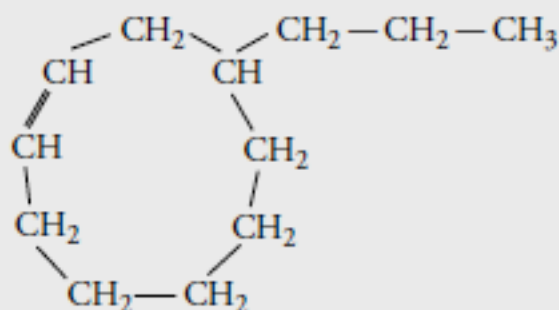
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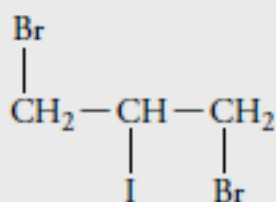
(i)



(j)



(k)



8. Both benzene and cyclohexane are flattened molecules with six carbons in a planar ring structure. These molecules can get very close to an adjacent molecule and so experience more London dispersion forces than hexane will. This greater amount of intermolecular forces will result in a higher boiling point.

Student Textbook page 582

1. Petroleum is a complex mixture of gaseous and liquid hydrocarbons in the form of natural gas, crude oil, and bitumen.
2. A petrochemical is a basic hydrocarbon raw material derived from petroleum, which is used to prepare plastics and other synthetic materials.
3. Each fraction has a different boiling point and molecular weight. This causes each fraction to condense at a different level within the fractionating tower.

4. Each hydrocarbon fraction has a unique range of boiling points. A large furnace vapourizes these fractions. Several plates inside a tower collect condensates from the rising vapourized fractions at levels where the temperature is just below the boiling points of those fractions. Larger hydrocarbons have higher boiling points, so they condense first at lower positions in the tower. Smaller hydrocarbons with lower boiling points rise higher in the tower to cooler levels before they can condense.
5. The cracking process uses heat to break larger hydrocarbon molecules into smaller more useful fragments. The reforming process uses heat, pressure, and catalysts to convert small molecules into more useful larger and/or aromatic fragments.
6. In cracking, large molecules are broken into smaller fragments. In reforming, smaller molecules are joined together to make larger molecules. Both processes involve catalysts.
7. The tube is switched when the temperature begins to rise drastically. Heat added to a substance during a change in state (vapourization) increases the distance between molecules but not their motion, so the temperature stays constant. Once one fraction is boiled away, there will be a shift to a new boiling point for the next fraction. Heat added causes molecules to move faster and the temperature will rise quickly until the next boiling point is reached.
8. Physically, the extraction requires draining of muskeg lands and stripping off of surface soils (overburden), damaging wildlife habitats and traditional lands of several indigenous peoples. Distribution of water from surface sources is altered and degraded in the separation and recovery process of bitumen. Upgraders release greenhouse gasses, sulfur dioxide, and nitrogen oxides into the atmosphere.

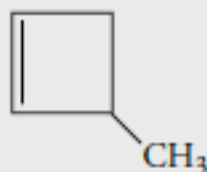
Answers to Understanding Concepts Questions

1. Organic compounds involve molecules in which carbon-carbon and carbon-hydrogen bonds are prevalent.
2. The concept of “vitalism” focussed on the idea that living creatures had the unique ability to form organic compounds. This concept was eventually rejected when organic compounds were synthesized from inorganic compounds in the laboratory.
3. Carbon has four valence electrons, which allow it to form strong covalent bonds with a variety of different elements. Carbon can form single, double, and triple bonds resulting in chains, rings, and sheets.
4. Most carbon-containing compounds are organic, although inorganic compounds can contain carbon. There are many millions of different organic compounds, but only about a quarter of a million inorganic compounds. Inorganic compounds are relatively small compared to most organic compounds. Most organic compounds are large and have a relatively high molecular mass.
5. Students might prepare something similar to the chart below.

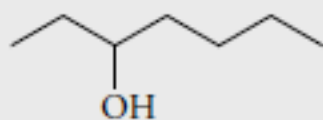
	Alkanes	Alkenes	Alkynes
Polarity	non-polar	non-polar	non-polar
Boiling point	lower than similar-sized alkenes and alkynes	usually slightly higher than similar sized alkanes but lower than similar-sized alkynes.	higher than similar-sized alkanes and alkenes.
Degree of saturation	saturated	unsaturated	unsaturated
Reactivity	less reactive than alkenes and alkynes	more reactive than alkanes but less reactive than alkynes	more reactive than alkanes and alkenes

6. (a) An aromatic hydrocarbon is one based on the aromatic benzene group.
- (b) Aliphatic hydrocarbons are not based on the benzene ring. They are compounds in which carbons form chains and non-aromatic rings. The electrons that form the double bonds in benzene are delocalized and do not react in the same way as the double and triple bonds in aliphatic hydrocarbons.
7. (a) C_nH_{2n+2}
- (b) C_nH_{2n}
- (c) C_nH_{2n-2}
- (d) C_nH_{2n}
- (e) C_nH_{2n-2}

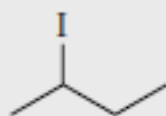
8. (a) aliphatic
(b) aromatic
(c) aliphatic
(d) aliphatic
(e) aromatic
9. (a) 2,3,4-trimethylpentane
(b) ethylcyclohexane
(c) 4-ethyl-4,5-dimethyloctane
(d) 2,3-dimethylpent-2-ene
(e) 1-ethyl-2-methylbenzene
(f) 3-methylbut-1-yne
10. No, that is not the correct name. Numbering priority is given to the double bond, with it being between positions 1 and 2. The correct name for this compound is 3-methylcyclobutene.



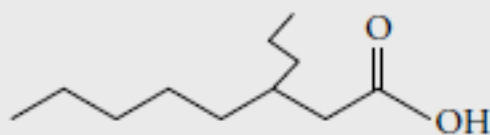
11. (a)



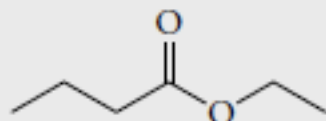
(b)



(c)



(d)



12. (a) hexanoic acid

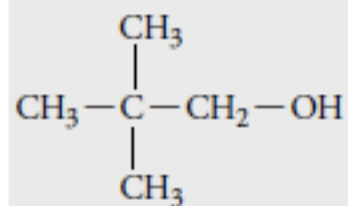
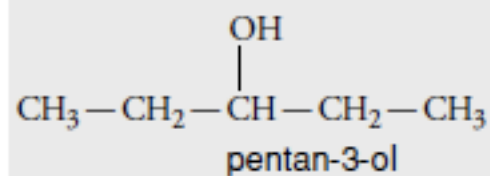
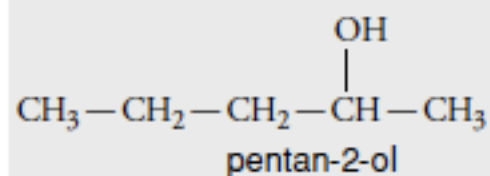
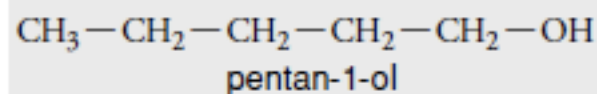
(b) methyl butanoate

(c) cyclopentanol

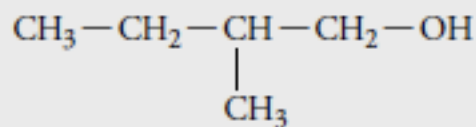
(d) 3-methylhexan-3-ol

(e) 1-bromo-2-iodoethene

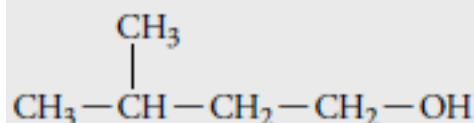
13. The eight isomers are:



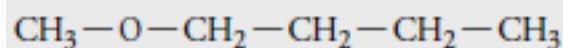
2,2-dimethylpropan-1-ol



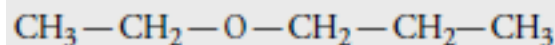
2-methylbutan-1-ol



3-methylbutan-1-ol



butylmethyl ether*



ethylpropyl ether*

*The students are not expected to name the ethers.

14. The carboxylic acid is slightly more polar than the ester because the polar covalent bonds between carbon and oxygen are at the end of the molecule and are more exposed. With more polarity, the carboxylic acid will be more soluble in water than the ester.
15. As the number of atoms (length) of an aliphatic compound increases, the number of London dispersion force interactions between adjacent molecules will increase. As a result of this, the boiling point will increase.
16. These hydrocarbon fractions have a different range of boiling points. Larger hydrocarbons, with higher boiling points, will condense at lower positions in the tower

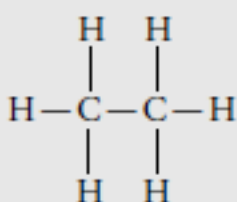
where temperatures are highest. Smaller hydrocarbons, with lower boiling points, remain in the gaseous state and will rise higher in the tower to cooler levels before they can condense.

Answers to Applying Concepts Questions

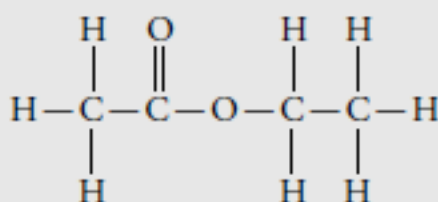
17. An alkane is more soluble in benzene because it is non-polar and like dissolves like. Alcohols are polar.
18. $\text{CH}_3\text{CH}_2\text{COOH}$ is likely to have the highest boiling point because of hydrogen bonding.

19. A bromine or potassium permanganate test will distinguish between an alkane and an alkene.
20. (a) Benzene has a six-membered ring structure in which six electrons are shared by all six carbon atoms. These shared electrons are said to be delocalized.
- (b) No, the branches are typically named and numbered before the root is named. It is also misleading to write that there are three double bonds when the structure is actually a resonance structure.
21. First, based on the empirical formula C_6H_{12} , only cycloalkane and alkene are possible. Next, determination of the boiling point could be performed, with comparison to the literature values for cyclohexane and the hexenes. In addition, bromine water or potassium permanganate could be reacted with the unknown to test for the presence of a double bond. The disappearance of colour would indicate hexene, the maintenance of colour would indicate cyclohexane. Reaction with iodine could also be used as a test, with the generation of a magenta colour indicating that the unknown was cyclohexane.
22. (a) A-ethane, B-ethyl ethanoate, C-ethanol, and D-ethanoic acid.

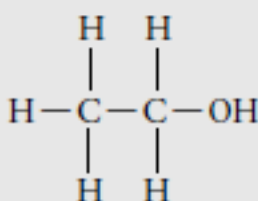
(b)



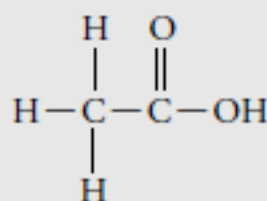
ethane



ethyl ethanoate



ethanol



ethanoic acid

Answers to Making Connections Questions

23. As the world's population grows and technological advances are made, the demand for energy is increasing rapidly. These developments, coupled with the fact that fossil fuels are nonrenewable resources that require millions of years to be produced, give people cause to worry that the world may run out of fossil fuels.

24. Alkanes

- gasoline and other fuels for cars and other engines
- natural gas to heat homes
- lubricating oils
- wax for candles
- asphalt and tar for paving and roofing

Alkenes

- ethene is used to ripen fruits and vegetables after shipping
- used to make plastics

Alkynes

- acetylene (ethyne) is used in welding torches

Cyclic Hydrocarbons

- found in steroid hormones

Aromatic Hydrocarbons

- includes styrene and toluene
- flavours and aromas – including wintergreen, vanilla and cinnamon

Alcohols

- used for solvents
- component in antifreeze
- fuels or fuel additives
- antiseptics
- component of alcoholic beverages

Alkyl Halides

- chloroform was used as an anesthetic
- CFCs (chlorofluorocarbons) were used as refrigerants and propellants

Carboxylic Acids

- vinegar is used as a flavouring
- citric acid is found in fruit

Esters

- both natural and artificial flavours and fragrances (including perfume)

- 25.** The tar-like substance is likely a long chain alkane, which is non-polar; therefore a non-polar solvent will remove the substance. Of the three substances, the least polar, the vegetable oil, would be most likely able to dissolve the tar-like substance.